



Wildlife and humans in outdoor recreational areas near cities

Outdoor recreational areas in the vicinity of cities buzz with activity, not only during the day, but also in the early mornings, late evenings, and even at night. This puts pressure on wild animals and their habitats. Roe deer are less active and many wildlife species are losing habitat in areas heavily frequented by humans. Wildlife refuges, restricted accessibility, and visitor management can improve living conditions for wildlife.

A growing population, sprawling settlements: More and more people go to near-natural green areas in search of relaxation, exercise, or a nature experience.¹⁻⁴ Activities like mountain biking and trail running are gaining popularity, and leisure activities are increasingly pursued in the early mornings, late evenings, and at night. Usually visitors use paths. But increasing visitor pressure can also lead to the creation of informal trails outside the official path and road network.⁵⁻⁷

Disturbances can weaken entire wildlife populations

Human activities can influence wildlife in various ways. The term «anthropogenic disturbance» is used when human activities affect wildlife negatively. Impacts differ between both species and individuals, and they also depend on the type, intensity, and predictability of disturbances.^{8,9} Anthropogenic disturbances can affect an individual animal directly, but in the longer term they can also influence entire wildlife populations.

Direct responses to disturbances include increased vigilance,¹⁰⁻¹² flight,¹³⁻¹⁷ changed spatial behaviour¹⁸⁻²² changed patterns of activity,^{21,23,24} avoidance of much frequented routes,^{25,26} or shifting of daytime periods of activity to the night hours.²⁵ Recurring or sustained disturbances increase the release of stress hormones in wildlife.²⁷⁻²⁹ Chronically elevated levels of

stress hormones can negatively affect reproduction, the immune system, and the survival of wildlife.²⁹ Studies of various wildlife species have found disturbance to result in reduced population densities and reproduction rates,^{30,31} increased energy expenditure,³²⁻³⁵ and weakened physical condition.^{36,37} In addition, disturbance can also influence feeding behaviour and food intake.^{11,24,26}

Recreational areas near cities are under-researched

To date, the influence of human recreational activities on wildlife has been studied mainly in fairly open areas that are scarcely or moderately used by humans.^[e.g. 8, 38, 39] Studies from forests in and around cities are largely lacking, even though wild animals in these forests experience much more severe and frequent anthropogenic disturbances.

Due to this lack of research, the findings presented in this factsheet are heavily based on a recently completed research project in the area of the Zimmerberg and Albis hill ranges, an important recreational area for people living in the conurbation of Zurich. The study area contains both remote areas with little human activity and areas that attract large numbers of visitors and have a dense network of roads and paths. Accordingly, the study area was categorized into areas of low,

medium, and high human use (Table 1). Apart from the Zurich Wilderness Park (Wildnispark Zürich), the study area is used for forestry, and with the exception of the park's core zone it is open for hunting. Roe deer may legally be hunted from the beginning of May (bucks; does beginning of September) to the end of December; females with offspring are protected.

Fifteen adult roe deer (9 does and 6 bucks) were fitted with telemetry collars containing an integrated motion sensor. The

behaviour of human visitors was recorded mainly by means of automatic counters and camera traps. For the investigation of specific research questions, individuals from certain user groups such as mountain bikers or orienteers were equipped with GPS loggers. This enabled spatially explicit monitoring of their interactions with roe deer. An analysis of the path and road network and interviews with forestry staff and hunters provided complementary data.

Table 1: Categorization of the study area into areas of low, medium, and high human use.

Intensity of use	Time of use	Type of use	Average distance to roads/paths [m]	Density of road/path network [km/km ²]
Low	Largely only on weekends	Mostly on roads and paths (due to vegetation and slope gradient); poor accessibility (no car park in direct vicinity)	56.5	8.3
Medium	On weekends and some weekdays	Mostly on roads and paths; good accessibility; large numbers of free-running dogs	42.8	9.6
High	On weekends and weekdays	Frequently off roads and paths; good accessibility; large numbers of free-running dogs	25.3	16.4

Athletes like to train in the mornings and evenings

Recreational areas near cities are visited more frequently on weekends than on weekdays (Fig. 1a). The daily number of visitors at the visitor counting site near the Gattikon forest pond (see Fig. 2) averaged 284 people overall, whereas the average on Sundays was 477 people. Around two-thirds of visitors moved on foot and one-third by bicycle. Both activities peaked in the mornings and afternoons. On weekdays, sports like mountain biking, cycling, and running were more frequently practised in the early mornings and in the evenings after work, whereas walkers and Nordic walkers were observed throughout the day. These patterns of use varied with the seasonal variations in the onset of dawn and dusk. Some activities took place after dark, although at a reduced level. This involved the use of illuminants, such as head torches and floodlights.

Studies in the project area and in other outdoor recreational areas around Zurich have shown that factors like high visitor pressure, an insufficient path network, or a path network that is not sufficiently tailored to visitors' needs can lead to the creation of informal trails. These trails cause additional disturbance in areas that might otherwise have provided a refuge for wildlife.^{40,41} However, visitor flows can largely be kept on the official path and road network by offering sufficient infrastructure geared to visitors' needs.^{2,42}

Roe deer move more in little used areas

The home ranges of the collared roe deer covered 39.7 hectares on average (see example in Fig. 2) and were more or less the same size on weekdays and weekends. However, they were considerably smaller during the daytime (i.e. when human visitors abounded) than at night, in both little and highly used areas. In areas of low human use, home ranges averaged 22.6 hectares during the daytime and 36.3 hectares during the night. In highly used areas, home ranges averaged 44.4 hectares during the daytime and 65.8 hectares during the night.

The roe deer generally preferred forested areas (79 per cent of all GPS positions), although at night they emerged into open areas more often than in the daytime. Only about 9 per cent of all daytime GPS positions were located in open areas, whereas this portion increased to 34 per cent during the night. This gives some indication of the role that dense vegetation for hiding and night-time cover play in the behaviour of roe deer.

The roe deer's activity patterns also varied markedly depending on the time of day: irrespective of the season, they proved to be more active at night than during the day (Fig. 1b). Their activity peaked at dawn and dusk, varying throughout the year according to the changing times of daybreak and night-fall. It is worth noting that roe deer in little used areas showed higher levels of activity at all times of day than their counterparts in highly used areas. This points to restricted movement

behaviour in response to anthropogenic disturbance, both during the day and at night.

Wild animals avoid forest roads

Analysis of the roe deer's habitat preferences within their home ranges clearly showed that they avoided forest roads almost without exception. This applied both during the day and at night, though less markedly so: The roe deer kept a distance to forest roads of at least 25 m during the daytime and 10 m at night. This is surprising, as the vegetation along forest roads is often particularly dense and offers roe deer plenty of food.

Roe deer were the main focus of the study, although forest breeding birds were investigated as well. The latter showed a similar avoidance of forest roads. In the Sihlwald forest as well as another forest intensively used for human recreation (Allschwil forest, Canton of Basel-Landschaft), researchers found substantially lower numbers of forest bird individuals and species at a distance of 50 metres from the nearest forest road than at a distance of around 150 metres.^{43,44} In scarcely visited but otherwise similar control forests no differences were found.

Roe deer flee farther when disturbed outside of official paths

When groups of mountain bikers passed closely by roe deer on official paths, the animals usually responded by fleeing a short distance. After about 10 minutes they returned to a pattern of movement similar to what they had shown prior to the disturbance.⁴⁵ At night, flight responses were slightly more pronounced than at dusk.

When people moved outside the official path network (e.g. during orienteering, hunting, or outdoor research), the roe deer fled farther on average. However, responses ranged from no flight (hiding in dense vegetation) to flight over a distance of around 1000 metres. After a disturbance, the roe deer generally sought cover in particularly dense vegetation.⁴⁶

Synthesis

Many humans encounter roe deer or other wild animals, sometimes at very close range. Such experiences are often taken as an indication that wild animals are not very shy and have become used to the presence of humans. Research using modern telemetry methods paints another picture, and is therefore indispensable in any attempt to gain a holistic understanding.

Roe deer are, indeed, highly adaptable. They are obviously able to live in areas that are easily accessible to and therefore intensively used by humans. However, the presence of humans substantially influences roe deer's spatial and temporal patterns of area usage. Forest roads crossing wildlife habitats restrict the movement and habitat selection of roe deer as well as of forest birds, and roe deer are less active but tend to have larger home ranges in areas of high human use. Taken together, this results in a quantitative and qualitative reduction of wildlife habitats in intensively used outdoor recreation areas near cities. The influence of human activities on wildlife behaviour is particularly strong when these activities take place outside the official path network.

The use of outdoor areas near cities for recreation encourages people to be physically active and thereby promotes human health. Swiss forests have very dense road and path networks compared to other countries, and hence offer many opportunities for recreational activities. The desire to experience nature is one of the main criteria determining people's choice of an outdoor area for recreation near their town or city. At the same time, however, this desire can cause conflicts with wild animals over the use of such areas.^{3,8} Management of such areas today should consider the needs of both humans and wildlife.



The roe deer received a telemetry collar that assessed GPS-positions and locomotion activity. (Photo: Roland F. Graf)



Roe deer were handled without narcosis. As a consequence, the animals could be released directly after fitting the GPS-collar. (Photo: Stefan Suter)



Nowadays, mountainbiking is not restricted to daylight as powerful headlights allow the sport also during the night. We investigated the reactions of roe deer to night-time biking in experimental situations. (Photo: Matthias Riesen)

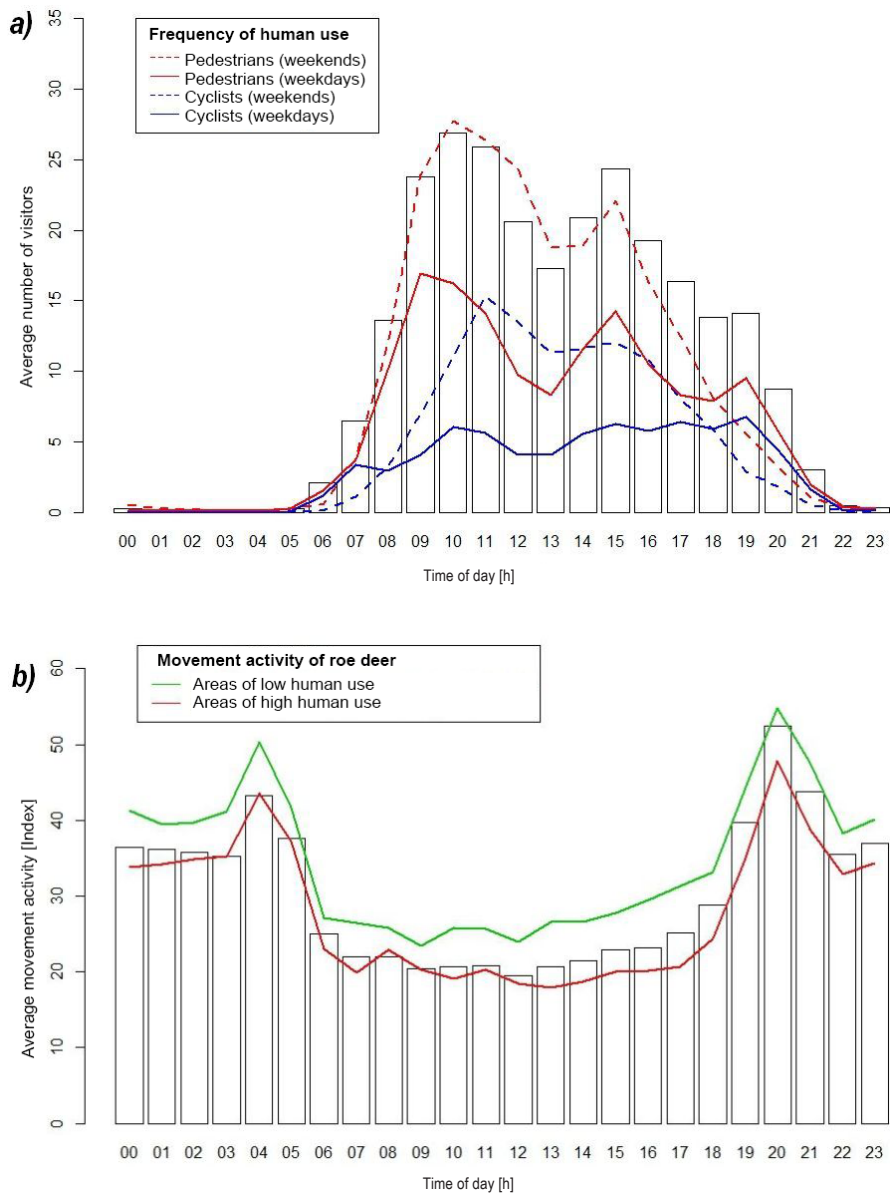
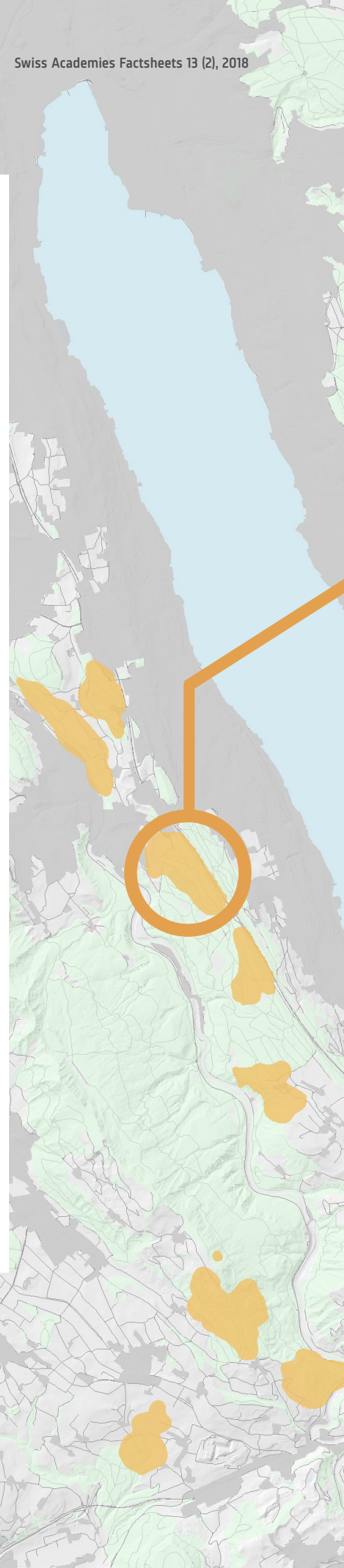


Figure 1: Daily patterns of (a) visitor numbers and (b) the movement activity of roe deer, taking the summer months (1 June to 31 August) as an example. The patterns are similar year-round but shift along with the changing onset of dawn and dusk. The different lines in (a) show the average numbers of pedestrians and cyclists passing the counting site on weekends and weekdays near the Gattikon forest pond, in a highly used area (see Fig. 2); the bars show the overall average daily visitor number at the counting site for each hour. The bars in (b) show the movement activity of the collared roe deer across the entire study area, whereas the lines show roe deer movement activity separately for areas of low and high human use.



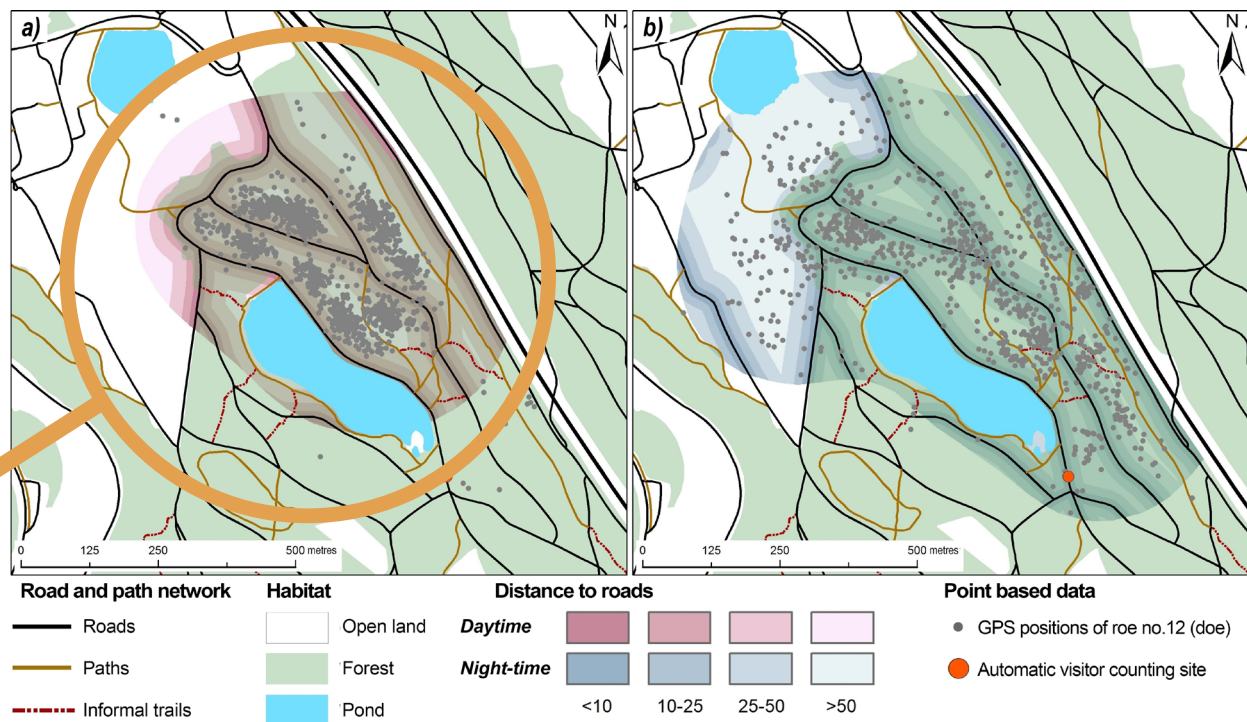


Figure 2: Example of the (a) diurnal and (b) nocturnal home range of roe deer no. 12 (doe) with the individual GPS points logged, in a part of the study area that is intensively used by humans. The Gattikon forest pond is situated on the southwest edge of the doe's home range (see Fig. 2a). Roads, official paths, and informal trails are shown as differently coloured lines; decreasing intensity of shading indicates increasing distance to roads.

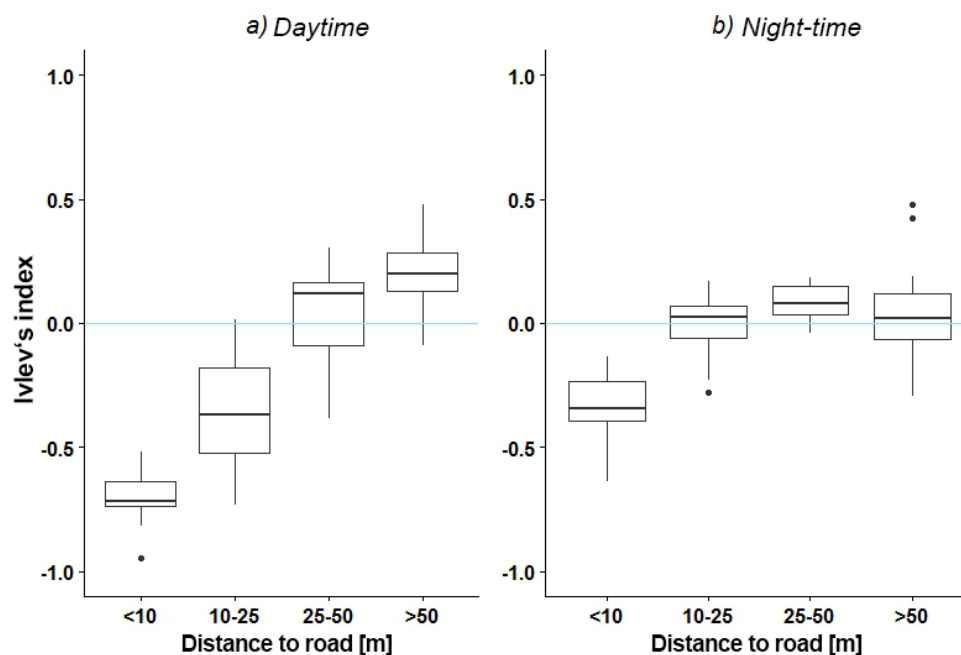


Figure 3: In the study area near Zurich, roe deer avoided proximity to forest roads both (a) during the day and (b) at night. Ivlev's index shows the degree of preference or avoidance of the four examined ranges of distance to forest roads: Values between 0 and 1 indicate preference, whereas values between 0 and -1 indicate avoidance.

Recommendations

In Switzerland, any person generally has the right to enter woodlands and meadows (Swiss Civil Code, Art. 699). At the same time, the cantons are obliged to adequately protect wildlife from disturbance (Federal Act on Hunting and the Protection of Wild Mammals and Birds, Art. 7). Many mountain regions have seen the establishment of wildlife refuges in recent years. This measure aims at protecting species that are particularly vulnerable to disturbance and at calming certain habitats. In the lowlands, the need for action has been deemed less urgent, possibly because winters are not as harsh at lower altitudes. Yet lowland wildlife is exposed to a particularly high level of disturbance.

In areas where there is latent conflict between various leisure activities and wildlife needs, the situation first needs to be assessed in a thorough analysis of uses. Which leisure activities are practised? Where, when, and how intensely do they occur? Where are particularly important wildlife habitats? Depending on the situation, uses can be separated by designating priority areas for human leisure activities and for wildlife, respectively. Before implementing concrete measures based on the use analysis, it is important to clarify the desired future situation and define objectives.

Specific management measures for outdoor recreational areas near cities

- Adequate road and path network density and undisturbed areas: In areas with a dense road and path network, elimination of certain roads and paths should be considered. New roads and paths should be compensated for by eliminating others, such as to maximize undisturbed areas.
- Needs-based infrastructure: The path network in outdoor recreational areas near cities should meet the needs of today's society. New developments must be monitored and considered in the planning and maintenance of recreational infrastructure. Activities should be separated where necessary.
- Concentration of human activities: New uses with a high potential of creating disturbance should be channelled to areas that are already unfavourable habitats for wildlife.
- Positive visitor management: A road and path network that meets visitors' needs will help to channel use of an outdoor recreational area. Natural barriers such as a dense shrub layer, heaps of branches, and dead wood lining paths make the forest less accessible, creating undisturbed refuges for wildlife. Simple signs for orientation and awareness creation should be placed in clearly visible places where necessary.
- Bans: If hard limits are unavoidable, they should be communicated clearly. Whenever possible the reason should be briefly explained. The feasibility of legal implementation and enforcement should be assessed beforehand.
- Awareness creation and communication: Many recreationists perceive the forest not only as their own recreational area, but also as the habitat of numerous animal and plant species. Despite this awareness, many people are not well informed about the impacts their activities have on wildlife. Awareness creation and participatory processes can deepen nature experiences and motivate forest users to help conserve forest habitats.
- Dynamic monitoring: The effectiveness of management measures in outdoor recreational areas near cities should be assessed at regular intervals. This way, existing measures can be optimized and complemented where necessary. Evidence of the efficacy of management measures creates long-term comprehension and acceptance of visitor management among users.

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